APPENDIX A

FLOW, CONCENTRATION, AND LOADS FOR SACRAMENTO URBAN RUNOFF, SACRAMENTO COMBINED SEWER OVERFLOW, AND MUD AND SALT SLOUGH DISCHARGES

Average loads were estimated for three of the selected discharges using the methods described in this appendix. Those discharges are:

Sacramento area urban runoff
Sacramento combined sewer system overflows (CSO)
Mud and Salt slough agricultural drainage

The purpose of these estimates is to obtain load calculations sufficiently adequate to compare to the loads calculated at the respective downstream benchmark locations (Greene's Landing and Vernalis) and thereby, at least roughly assess the proportion and significance of these discharges. The methodology and the flow and concentration data used in calculating loads for these discharges are presented in this appendix.

Sacramento Area Urban Runoff

Loads were not calculated for this study for Sacramento area urban runoff. Rather, all load numbers for Sacramento area urban runoff are cited from Larry Walker Associates (LWA) Discharge Characterization study. LWA used a continuous simulation model of their own design to estimate Sacramento area wet season urban runoff mass loads for selected contaminants, including total dissolved solids (TDS) and ammonia. LWA used Sacramento urban runoff water quality data collected from 1990 to 1992 (all dry water years). Their method, based on four discharge locations with discharge volumes estimated from sump pump run times, developed an estimated runoff mass per impervious area to arrive at total mass. No endorsement of this study is intended as their report does not describe the methodology in sufficient detail to completely follow or reproduce their results. Their results are shown in Table A-1.

The LWA report also calculated loads for several contaminants (including TDS and ammonia) for dry season discharges. However, the loads were calculated only for the four sump locations. The model was not used to simulate dry season loads for the entire Sacramento urban area. It is, however, interesting to note that dry season loads were generally comparable to wet season loads. TDS loads, though, appear to be higher in dry season discharges. This may be due to the runoff of applied groundwater in dry season discharges.

Table A-1. Sacramento Area Urban Runoff TDS Concentrations and Loads for Dry Year/Wet Season Conditions

Contaminant	Combined median event mean concentration, mg/l[a]	Load, lbs/wet season[a,b]	Load, lbs/day[c]
Arsenic	0.002	--	--
TDS	95	20,513,700	135,852
Total phosphorus	0.3	--	--
Nitrate plus nitrite as N	0.9	--	--
Ammonia	0.5	12,900	85

[a]All data are cited from Larry Walker Aassociates Discharge Characterization Report.
[b]Wet season is not specifically defined in the report, but is assumed to be longer than the wet season defined for this study.
[c]Pounds per day roughly estimated by dividing lbs/wet season by 151 days, the number of days from December through April.

In an attempt to calculate loads for contaminants not included in the LWA study, this project team calculated loads based on a Central Valley Regional Water Quality Control Board (Regional Board) estimate of the annual volume of urban runoff discharged from the Sacramento area and Fresno urban runoff water quality data. The Regional Board volume estimate is based on a simple rainfall times acreage times runoff coefficient equation applied to the 1984/85 water year (which was a wet year). The Fresno data were collected from 1981 to 1983. Use of the Regional Board volume estimates and the Fresno data appeared to grossly overestimate possible loads. No other estimates of Sacramento urban area runoff discharge volume are available. Individual pump run times are available for the city sumps, but it is beyond the scope of this study to work with data in such raw form. Therefore, no further attempt was made to calculate Sacramento area dissolved organic carbon urban runoff loads for this study.

Sacramento CSO Discharges

The water quality and flow data used by the project team to calculate loads of contaminants in the CSO discharges were collected by the City of Sacramento. The city began sampling and measuring flow on CSO discharges in 1990. The volume data is reported separately for 1991/1992 (a dry year) and for 1992/1993 (a wet year). The water quality data are, however, reported as averaged over the entire sampling program. The city measures the

volume of discharge and collects water quality data at each of the three CSO discharge locations. Those locations are:

1. The Combined Wastewater Treatment Plant,
2. Sump 2, and
3. Pioneer Reservoir.

The average daily load during the wet season of a wet year (1993) and the wet season of a dry year (1992) was calculated for each of these locations and then summed. The equation used to calculate the load at each discharge location was:

Load (lbs/day) = volume (MG/151 days) x C (mg/l) x 8.34 lbs/gal

where there are 151 days in the wet season as defined for this study (December through April).

Discharge volumes, concentrations, and loads are shown below in Tables A-2 and A-3.

Table A-2. Sacramento Combined Sewer Overflow Discharge Volumes Concentrations for Dry Year/Wet Season and Wet Year/Wet Season Conditions[a]

Contaminant	Combined wastewater treatment plant	Sump 2	Pioneer Reservoir
1991/1992 wet season discharge, mg			
1992/1993 wet season discharge, mg	460	240	40
Arsenic, mg/l	0.002	0.002	0.0005
TDS, mg/l	207	68	69
Total phosphorus, mg/l	0.9	1.1	0.9
Nitrate, mg/l	1.1	0.3	0.6

[a]Data from City of Sacramento.

Mud and Salt Slough Discharges

Average daily loads were calculated for Mud and Salt Slough based on U.S. Geological Survey (USGS) flow and water quality data. The USGS maintained a flow measurement and water quality sampling location on these sloughs between late 1985 and 1988. The water years were classified as 1986 (Wet), 1987 (Critical), and 1988 (Critical). Data were collected bimonthly. Flow and water quality data were averaged for each slough for wet year/wet season, wet year/dry season, dry year/wet season, and dry year/dry year season and then summed.

The equation used to calculate annual loads was:

Load (lbs/day) = Q (cfs) x 0.64632 mgd/cfs) x C (mg/l) x 8.34 lbs/gal

Table A-3. Sacramento Combined Sewer Overflow Loads for Dry Year/Wet Season and Wet Year/Wet Season Conditions

Contaminant	Loads, lbs/day	
	Dry year/ wet season	Wet year/ wet season
TDS		6,315

Table A-4. Mud and Salt Sloughs Average Flow During Wet Year/Wet Season, Wet Year/Dry Season, Dry Year/Wet Season, Dry Year/Dry Season[a]

Season type	Flow, cfs	
	Mud Slough	Salt Slough
Wet year/wet season	190	260
Wet year/dry season	65	310
Dry year/wet season	80	280
Dry year/dry season	40	290

[a]USGS flow data.

Table A-5. Mud and Salt Sloughs Average Total Organic Carbon Concentration During Wet Year/Wet Season, Wet Year/Dry Season, Dry Year/Wet Season, Dry Year/Dry Season[a]

Season type	Total organic carbon, mg/l	
	Mud Slough	Salt Slough
Wet year/wet season	16	10
Wet year/dry season	10	9
Dry year/wet season	12	9
Dry year/dry season	10	9

[a]USGS water quality data.

Table A-6. Mud and Salt Sloughs Average Total Dissolved Solids Concentrations During Wet Year/Wet Season, Wet Year/Dry Season, Dry Year/Wet Season, Dry Year/Dry Season[a]

Season type	Total dissolved solids, mg/l	
	Mud Slough	Salt Slough
Wet year/wet season	1,680	1,710
Wet year/dry season	1,810	750
Dry year/wet season	2,130	1,630
Dry year/dry season	1,620	1,110

[a]USGS water quality data.

Table A-7. Mud and Salt Sloughs Total Loads During Wet Year/Wet Season, Wet Year/ Dry Season, Dry Year/Wet Season, Dry Year/Dry Season

Season type	Load, lbs/day; Mud and Salt Slough	
	Total organic carbon	Total dissolved solids
Wet year/wet season	30,850	4,094,000
Wet year/dry season	18,500	1,875,000
Dry year/wet season	18,700	3,372,000
Dry year/dry season	16,400	2,117,000